DOI: 10.23934/2223-9022-2019-8-2-194-202

Infectious Complications of Abdominal Wall Damage with a Car Seat Belt. The Experience of Treatment in Four Patients

A.G. Lebedev, T.P. Makedonskaya*, V.D. Levitsky, A.V. Sachkov, N.V. Shavrina, O.K. Kaloyeva, P.A. Yartsev

Department of Emergency Surgery, Endoscopy and Intensive Therapy
N.V. Sklifosovsky Research Institute for Emergency Medicine
3 Bolshaya Sukharevskaya Square, Moscow 129090, Russian Federation

*** Contacts:** Tatyana P. Makedonskaya, Candidate of Medical Sciences, Researcher of the Department of Emergency Surgery, Endoscopy and Intensive Therapy, N.V. Sklifosovsky Research Institute for Emergency Medicine of the Moscow Health Department. E-mail: makeda3@yandex.ru

ABSTRACT Seat belt syndrome is a triad of symptoms: body belt marks (hemorrhages, ecchymosis, abrasions on the abdominal wall), intra-abdominal trauma and spinal fractures in the thoracic and lumbar spine. The abdominal mark of a safety belt implies a complex diagnostic algorithm to exclude injury to the intra-abdominal organs and the abdominal wall. The clinical picture of damage is not specific, which leads to errors in diagnosis or delays at the beginning of the examination protocol. A dynamic examination of the patient (ultrasound, CT, X-ray) is necessary. The damage to the abdominal wall with a seat belt, which entailed the development of septic complications, require long-term general and local treatment, additional diagnostic methods and surgical interventions.

Keywords: seat belt syndrome, intra-abdominal organs injury, abdominal seat belt mark, infectious complications, abdominal wall injury
For citation Lebedev A.G., Makedonskaya T.P., Levitsky V.D., et al. Infectious complications of abdominal wall damage with a car seat belt. The experience of treatment in 4 patients. *Russian Sklifosovsky Journal of Emergency Medical Care.* 2019; 8(2): 194–202. DOI: 10.23934/2223-9022-2019-8-2-194-202 (In Russian)
Conflict of interest Authors declare lack of the conflicts of interests
Acknowledgments The study had no sponsorship
Affiliations

Aleksandr G. Lebedev	Doctor of Medical Sciences, Chief Researcher of the Department of Emergency Surgery, Endoscopy and Intensive Therapy, N.V. Sklifosovsky Research Institute for Emergency Medicine, ORCID: 0000-0003-4008-6462.
Tatyana P. Makedonskaya	Candidate of Medical Sciences, Researcher of the Department of Emergency Surgery, Endoscopy and Intensive Therapy, N.V. Sklifosovsky Research Institute for Emergency Medicine, ORCID: 0000-0003-3884-6207.
Aleksey V. Sachkov	Candidate of Medical Sciences, Head of the Scientific Department of Acute Thermal Lesions, N.V. Sklifosovsky Research Institute for Emergency Medicine, ORCID: 0000-0003-3742-6374.
Natalia V. Shavrina	Researcher of the Department of Emergency Surgery, Endoscopy and Intensive Therapy, N.V. Sklifosovsky Research Institute for Emergency Medicine, ORCID: 0000-0002-3766-4674.
Olga H. Kaloyeva	Junior Researcher of the Department of Radiology Diagnostics, N.V. Sklifosovsky Research Institute for Emergency Medicine, ORCID: 0000-0002-50580512.
Vladislav D. Levitsky	Candidate of Medical Sciences, Leading Researcher of the Department of Emergency Surgery, Endoscopy and Intensive Therapy, N.V. Sklifosovsky Research Institute for Emergency Medicine, ORCID: 0000-0003-1100-486X.
Pyotr A. Yartsev	Doctor of Medical Sciences, Professor, Head of the Scientific Department of Emergency Surgery, Endoscopy and Intensive Therapy, N.V. Sklifosovsky Research Institute for Emergency Medicine, ORCID: 0000-0003-1270-5414.

INTRODUCTION

In a car accident, the victims experience characteristic damage with a fastened seat belt, which intensity directly depends on the speed, as inertia force transmitted to the body is greater. Three-point safety shoulder-lap belts are used today, which reduce the risk of death and severe damage in car accidents by 25 times [1-3]. Holding the passenger's body from throwing it away, the seat belt itself, however, is the cause of the damage. The SBS (Seat Belt Syndrome) was first described by Garrett and Braunstein in 1962 as a linear abdominal ecchymosis after a car accident [2]. Classically, this is a triad of symptoms, signs of a safety belt on the body (Fig. 1): a) hemorrhages, ecchymosis, abrasions on the abdominal wall; b) injury of abdominal organs; c) spinal fractures in the thoracic and lumbar regions [4, 5]. The abdominal seat belt sign (ASBS) (Fig. 1) has an established connection with abdominal trauma in 30% of cases and therefore suggests an extended diagnostic complex to exclude injury to abdominal organs and the abdominal wall [6–9]. The location of ASBS and its depth according to the results of computed tomography (CT) gives an idea of the prevalence of abdominal wall contusion. The ratio of the thickness of the abdominal wall and the depth of contusion in the damaged segment with respect to the anterior superior iliac spine allows the abdominal seat belt sign index (ASBSI) to be calculated. The index is a prognostic criterion for damage to the abdominal organs, if ASBS is above the upper spine of the ilium [8]. The abdominal wall trauma with damage to muscles is quite rare [10–12]. The clinical picture of SBS is non-specific, which leads to errors in diagnosis or delays at the beginning of the examination protocol. The dynamic examination of the abdominal cavity (ultrasound, CT, X-ray) is necessary, as peritoneal symptoms may be hidden or appear over time [12, 13]. The main areas of damage in the abdominal cavity are the ileocecal region, the sigmoid area and jejunum. Most often it is damage to two or more areas, in 60% of cases resulting in bowel perforation [14]. SBS treatment is not standard and depends on the number, severity of injuries, the general condition of a patient and may vary from conservative to surgical, which affects the outcome of the injury [4, 15]. The abdominal wall trauma, which led to the development of purulent complications, is not sufficiently covered in the literature. Clinical observations show that even with an intestinal injury, complications from traumatic injuries of the abdominal wall and retroperitoneal space associated with a seat belt may have more severe manifestations, septic complications, and intoxication. In such

cases, long-term general and local treatment, additional methods of diagnosis and surgical intervention are required: both mini-invasive and open access to eliminate leakages and treat the abdominal wall and retroperitoneal phlegmon, aspiration, lavage and vacuum dressings.

Fig. 1. ASBS (Abdominal Seat Belt Sign)

In 2018, we treated 4 patients with *SBS* in combination with traumatic injury to the abdominal wall and the subsequent development of inflammatory changes in the fiber. In all patients, predictors of intra-abdominal trauma (ASBS) were observed. The severity of the abdominal cavity trauma varied from minimal hemoperitoneum and subserous hematomas of the caecum to rupture of the mesentery of the small intestine with necrosis and peritonitis. Abdominal wall injuries had different degrees of severity: superficial hematomas, rupture of the rectus abdominis muscle, local post-traumatic abscesses, extensive necrotic phlegmon of the anterior abdominal wall and lateral walls of the abdomen, which in some cases required minimally invasive interventions, drainage under the ultrasound guidance, repeated sanitation, necrotomy and autodermoplasty.

A 37-year-old male patient S. was delivered to the Institute 80 minutes after a car accident. ASBS upon examination (Fig. 2). The further examination revealed no bone, craniocerebral injury or damage to the chest organs. The presence of fluid in the abdominal cavity required a diagnostic video laparoscopy 5 h after admission. Two subserous hematomas of the caecum cupula with a diameter of up to 1.5–2.0 cm with a site without serous coat and minimal hemoperitoneum were revealed. The drainage of the abdominal cavity was performed. The patient was discharged in a good condition 5 days later.

Fig. 2. A 37-year-old male patient S. with marks of an abdominal seat belt, 5 hours after admission

A 42-year-old male patient F. was transferred from another medical institution on the 11th day after trauma with the diagnosis: "Severe multisystem injury of the head, chest, abdomen, pelvis, limbs." The dominating pathology was abdominal trauma with damage to the small intestine, sigmoid colon, rupture of the mesentery of the small intestine with intra-abdominal bleeding, rupture of the rectus abdominis muscle with the formation of hematoma of the soft tissues of the anterior abdominal wall and chest injury with multiple rib injury, hemopneumothorax. Laparotomy, suturing of the mesentery of the small intestine, colostomy were performed. The ultrasound of the abdominal organs on the 13th day after injury revealed signs of fluid accumulation in the anterior abdominal wall in the projection of the left iliac fossa. The fluid accumulation was drained under the ultrasound guidance, 70 ml of purulent discharge with an admixture of “old” blood were simultaneously evacuated. The fistulography on the 21st day after trauma (day 8 after drainage) showed no communication with the free abdominal cavity or hollow organs, aspiration was satisfactory (Fig. 3). The fistulography on the 29th day after injury (on the 16th day after drainage): decreased cavity size, satisfactory aspiration (Fig. 4). The CT scan of the abdominal cavity (on the 37th day after injury) revealed fluid accumulation in the area of a hematoma drained earlier in the abdominal wall and infiltrative changes in the tissue of the anterior abdominal wall (Fig. 5). The fluid was punctured under the ultrasound guidance, 15 ml of serous discharge were evacuated. The patient was discharged on the 33rd day. after injury in satisfactory condition. The continuity of gastrointestinal tract was restored 6 months later. The patient was discharged on the 10th day without complications.

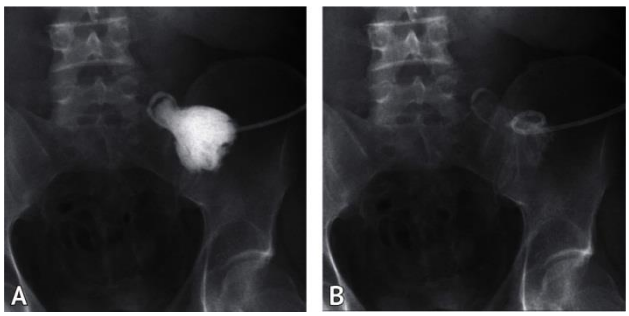

Fig. 3. A 42-year-old male patient F. The fistulography image on day 21 after trauma. A cavity of 5.0 x 3.0 x 3.5 cm, irregular shape, clear and uneven contours was contrasted when introducing a contrast agent into the drainage tube. No fenestration with a free abdominal cavity or hollow organs was detected (A). Satisfactory aspiration from the cavity (B)

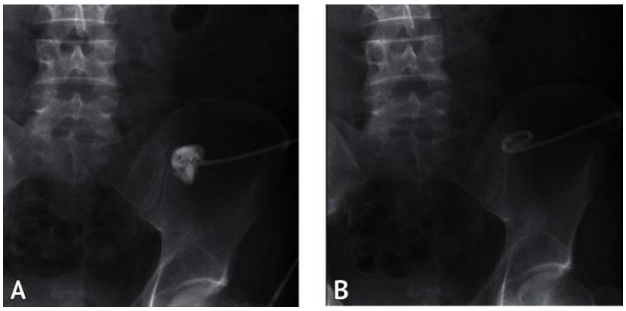

Fig. 4. A 42-year-old male patient F. The Control fistulography image on day 39 after trauma. A cavity of 3.5x3 cm, irregular shape, clear and uneven contours was contrasted when introducing a contrast agent into the drainage tube. No fenestration with a free abdominal cavity or hollow organs was detected. The volume of the cavity decreased (A). Satisfactory aspiration (B)

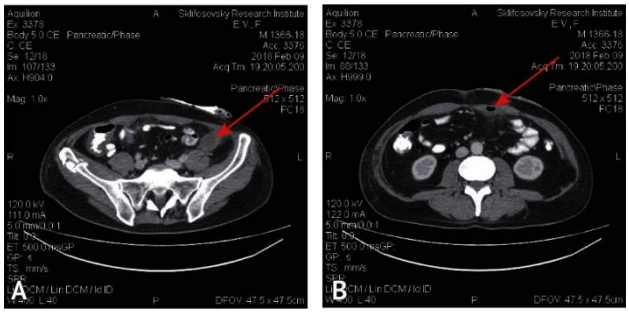

Fig. 5. A 42-year-old male patient F. The CT scan on day 37 after trauma. The localized fluid accumulation of 18 cm^3 (initially 95 cm^3) was revealed in the anterior abdominal wall in the projection of the left iliac region (A). A nonuniform area due to gas inclusions was revealed in the muscles of the anterior abdominal wall, which didn't accumulate a contrast agent. The fiber adjacent to this area was infiltrated (B)

A 44-year-old female patient M. was transferred from another medical institution on the 2nd day after trauma with the diagnosis: "Severe multisystem injury, closed abdominal trauma, rupture of the small intestine, contusion of the right kidney, perirenal hematoma. Multiple hematomas of the anterior abdominal wall, left buttock. Fracture of the medial ankle of the right tibia with displacement. Type 2 diabetes". Laparotomy and suturing the rupture of the small intestine were performed. Upon admission, ASBS predictors were detected on the anterior abdominal wall (Fig. 6). On the 8th day after injury, the patient noted pain in the left lateral area of the abdomen, hyperthermia was up to 38°C, and hyperemia in the hematoma area of the anterior abdominal wall. Drainage of suppurative post-traumatic hematoma was performed with additional drainage and correction of the previously established drainage on the 12th day after injury, aspiration and sanitation were initiated. The fistulography on the 2nd day after drainage revealed a cavity in the tissue of the anterior abdominal wall of 24.0x5.5 cm with unclear uneven contours. There were no communication with the free abdominal cavity and hollow organs (Fig. 7). The CT scan of the abdominal cavity (18th day after injury, Fig. 8) and dynamic ultrasound examination on the 21st and 28th day after injury revealed additional abscesses of the anterior abdominal wall and the left buttock, requiring drainage under the ultrasound guidance. The check fistulography on the 39th day after injury showed cavities decreased in size, aspiration was satisfactory (Fig. 9). On the background of complex antibacterial, immunoprotective therapy, aspiration and treating of wounds, positive dynamics was achieved, the drains from the abdominal wall were removed on the 45th day after injury, and on the 52nd day from the gluteal region. The patient was discharged on the 57th day after injury in satisfactory condition.

Fig. 6. A 44-year old female patient M. Abdominal Seat Belt Sign

Fig. 7. A 44-year-old female patient M. A cavity with uneven unclear contours of 24.0x5.5 cm was determined when introducing a contrast agent into a drainage tube installed in the soft tissues of the anterior abdominal wall. No fenestration with the free abdominal cavity or hollow organs was revealed (A, B). Passive and incomplete aspiration (C)

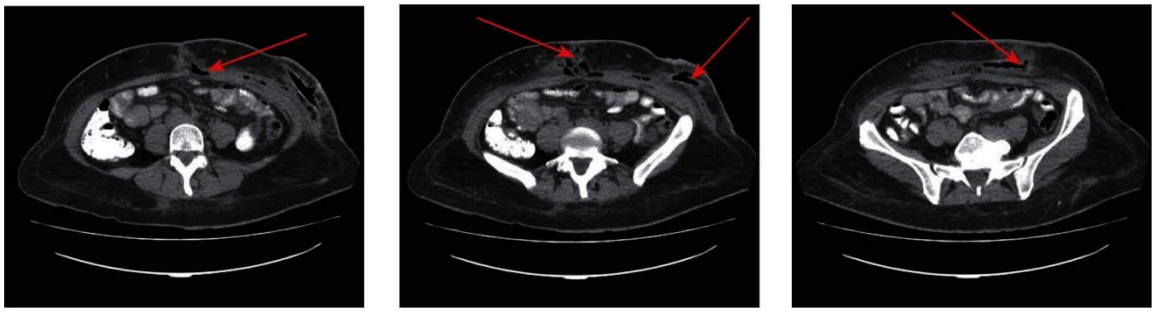

Fig. 8. A 44-year old female patient M. CT-signs of infiltrative and inflammatory changes in the soft tissues of the anterior abdominal wall in the anterior-left regions with the formation of an undrained liquid area

Fig. 9. A 44-year old female patient M. An irregularly shaped cavity with dimensions up to 8.7x4.3x2.0 cm was detected. No fenestration with hollow organs or pelvic cavity was detected when introducing a contrast agent into a drainage tube installed in the soft tissues of the left buttock. The contours of the cavity were unclear and uneven. Satisfactory aspiration (A, B). An irregularly shaped cavity with dimensions up to 4.6 x 3.7 cm was determined when introducing a contrast agent into a drainage tube installed in the soft tissues of the anterior abdominal wall. The contours of the cavity were clear and even. No fenestration with a free abdominal cavity or hollow organs was detected. Satisfactory aspiration (C, D).

A 56 year-old male patient S. was transferred from another medical institution on the 2nd day after trauma in severe condition with a multisystem injury of the head, chest, abdomen and multiple focal brain infarctions (cardioembolic pathogenetic variant according to TOAST (Trial of ORG 10172 in Acute Stroke Treatment). Laparotomy was performed, multiple small intestinal ruptures and signs of peritonitis were detected. The resection of 1.5 m of the small intestine with the imposition of an anastomosis, sanitation and drainage of the abdominal cavity were perfromed. Upon admission, the patient's condition was caused by toxic shock, abdominal sepsis, multiple organ failure, endothelial dysfunction syndrome, adult respiratory distress syndrome. On the skin of the trunk, abdominal wall, inguinal areas, lateral surfaces of the abdomen, there were confluent hematomas with fiber infiltration, contused wounds covered with a dry scab in both inguinal areas (Fig. 10). These are predictors of ASBS. We started a massive detoxification, antibacterial, immunoprotective, symptomatic therapy, carrying out active methods of detoxification. Despite the treatment, the condition remained critical due to the full-scale picture of multiple organ failure in the background of the systemic inflammatory response syndrome. Severe respiratory and cerebral insufficiency remained leading in severity. On the 8th day after trauma, the appearance of hyperemia, infiltration in the area of hematomas of

the left abdominal wall was noted, the skin in these area was hot. Inflammatory changes spread along the lateral surface and downwards (Fig. 11). Palpation in the area of hurt wounds (necrotic skin area 4x5 cm) defined unclear fluctuation. In lab tests inflammatory changes increased: leukocytosis $14.8x10^9$, stab shift up to 12%, relative lymphopenia 2%. Ultrasound and CT of soft tissues showed signs of hematoma of the abdominal wall on the left (lateral surface involving the anterior wall, to the left inguinal region) with edematous-infiltrative changes of subcutaneous fatty tissue (Fig. 12). Under local anesthesia, hematoma was drained on the left in the inguinal and iliac region: a cavity of 15x8 cm was found in the subcutaneous tissue, extending laterally to the iliac crest and to the lower lateral surface of the left abdominal wall. The drains were connected to the drainage system. The samples had mixed flora *(Acinetobacter sp., Enterococcus faecalis, Staphylococcus Coag (-), Candida albicans)*, sensitive to carbopenems (the patient received Meronem 6 g/day from the first day). In the area of hematoma on the right in and in the site of the former drainage of the abdominal cavity, purulent discharge was also detected. A double-lumen drainage was blindly placed along the subcutaneous tissue. The next day, the patient's condition was severe, with deterioration. The body temperature was 38.9° C. The skin over the hematoma in the left iliac bone was hyperemic, swollen, hot. On the right side of the abdomen there was an area of infiltration and hyperemia, extending downward, the inflammation increased. On the 9th day after trauma, an incision was made in the skin and subcutaneous tissue in the left lateral area under endotracheal anesthesia. There was black necrotized subcutaneous tissue with purulent discharge. The revision detected a detachment of subcutaneous tissue from above to the lower third of the midline suture, extending through the midline above the pubis to the right side of the abdominal wall. The lower border of the detachment to the projection of the external inguinal ring. Laterally, the phlegmon zone extended along the lateral surface of the abdominal wall to the level of the X–XI rib. This area was a single huge cavity of exfoliated fiber with necrosis (Fig. 13 A). The ventral sheath of the the external oblique muscle of the abdomen was grayish with areas of necrosis. From an opening of a previously installed drainage pus came out under pressure. The outer aponeurosis was opened. A purulent cavity was revealed, going extraperitoneally posteriorly and upward, corresponding to the projection of the left lateral canal. The medial wall of this cavity was preperitoneal tissue, the lateral one was the abdominal wall. The length of this pocket is at least 20 cm. In the right side there was also an incision in the skin and subcutaneous tissue. There was necrosis of the subcutaneous tissue with copious purulent discharge. The area of the detachment on the right medially communicated with the opposite cavity, from above it was limited to a small pocket with necrosis, extended from below to the projection of the external inguinal ring, laterally it extended before the projection of the iliac crest (Fig. 13). A necrectomy was performed, the walls of the cavity were treated with Folkman's spoon, repeatedly washed with hydrogen peroxide solution and antiseptic. The drainage and plugging of the subcutaneous tissue were performed (Fig. 14). We conducted daily dressings, aspiration and sanitation. The intoxication grew again by the 19th day. The CT scan revealed a limited fluid accumulation extraperitoneally to the left (Fig. 15). On the 22nd day, a phlegmon was inspected, a significant decrease in necrotic tissue was detected, the area of detachment in the subcutaneous tissue was maintained, and necrotic changes in the abdominal wall in the region of the middle suture were noted (Fig. 16). The samples had mixed flora *(Klebsiella pneumoniae, Acinetobacter spp., Pseudomonas aeruginosa)*, the antibacterial therapy was changed according to the results of sensitivity. Given the large area of the wound surface (about 10% of the body surface), vacuum treatment method was performed (vacuum-assisted closure), which allowed to achieve a significant cleansing of the wound surface and reduce its area (Fig. 17). On the 34th day after trauma, the patient was transferred to the surgical department after stabilization, where the combined therapy dressings were continued, the wound on the right was sutured (Fig. 18A), the wound on the left was treated by a vacuum method (Fig. 18 B, C). *Acinetobacter spr* ., resistant to antibiotic therapy, was found in samples from the wound on the right. On the 49th day after injury due to the continuing soft tissue defect in the wing area of the left iliac bone with dimensions of 4x12 cm, autodermoplasty was performed with a free skin flap (Fig. 19). The patient was discharged on the 61st day after injury in a stable condition, the graft was viable (Fig. 20).

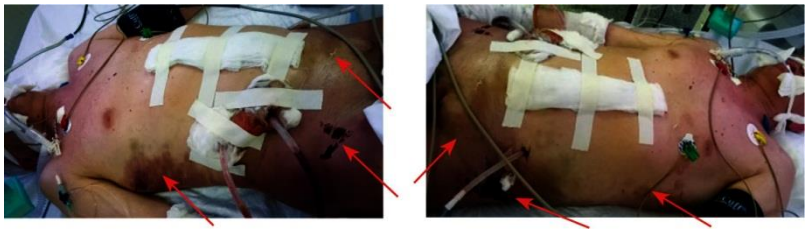

Fig. 10. A 56-year-old male patient S. Abdominal Seat Belt Sign. Hematomas and superficial wounds of the body

Fig. 11. A 56-year-old male patient S. Hyperemia and infiltration of the anterior abdominal wall in the area of hematomas on the right (A) and on the left (B)

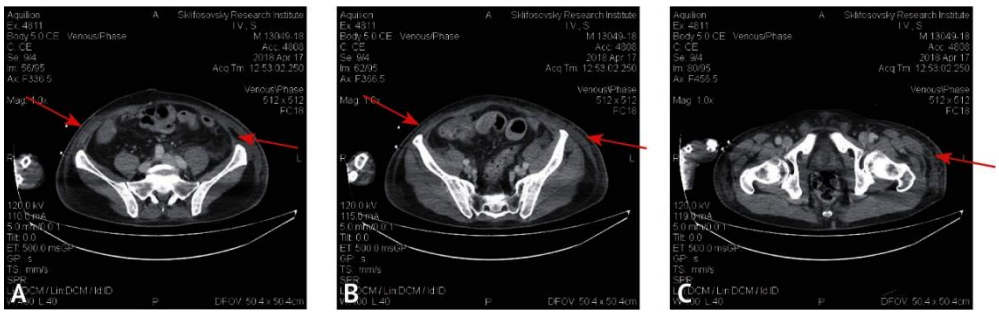

Fig. 12. A 56-year-old male patient S. The CT scan. Infiltrative and inflammatory changes in the fiber of the anterior abdominal wall

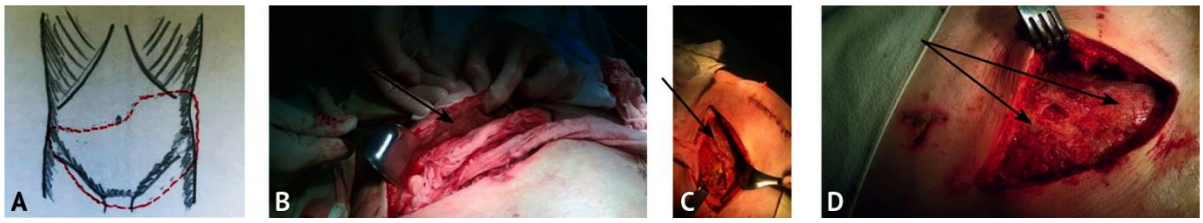

Fig. 13. A 56-year-old male patient S. on day 9 after trauma. The phlegmon area (indicated by a dotted line). Necrosis of the subcutaneous tissue on the left (B), aponeurosis (C), necrosis of the subcutaneous tissue on the right (D)

Fig. 14. A 56-year-old male patient S. The layout of drainages

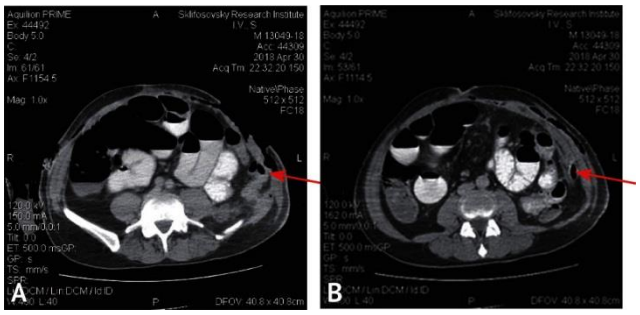

Fig. 15. A 56-year-old male patient S. The localized extraperitoneal fluid accumulation on the left

Fig. 16. A 56-year-old male patient S. on day 22 after trauma. The significant reduction in necrotic tissues (A). The area of subcutaneous tissue detachment preserved (B). Necrotic changes in the abdominal wall in the lower third of the median suture (C)

Fig. 17. A 56-year-old male patient S. on day 27 after trauma. Vacuum treatment of wounds (Vacuum-assisted closure (VAC) therapy) with a significant debridement of the wound surface and reduction of its area

Fig. 18. A 56-year-old male patient S. on day 34–36 after trauma. A — a wound of the abdominal wall on the right with U-shaped sutures; B, C — vacuum dressing of the abdominal wound on the left

Fig. 19. A 56-year-old male patient S. on day 49 after trauma. Autografting with a free flap

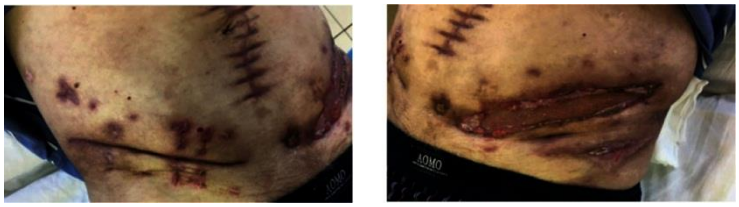

Fig. 20. A 56-year-old male patient S. on day 61 after trauma. The abdominal wall with postoperative scars and viable graft

DISCUSSION

All the presented clinical observations are similar in the mechanism of injury, SBS predictors of intra-abdominal injury and post-traumatic damage to the abdominal wall with the development of purulent-inflammatory changes [4–9]. In 2 cases, changes in the fiber appeared on the 8th day, in one case they appeared on the 13th day. Hematomas and skin abrasions in the area of abdominal wall damage, subcutaneous tissue, retroperitoneally and deep in the muscles should be the reason for the targeted study of the abdominal wall and retroperitoneal space by ultrasound diagnostics on day 8–10 after trauma. This will reveal the delimited fluid accumulations, hemorrhagic soaking, infiltrative changes, hematomas with muscle damage [12, 13]. The indications for mini-invasive treatment methods are the presence of delimited fluid accumulations in the abdominal wall and retroperitoneal tissue and the possibility for manipulation (the presence of an acoustic window). Subsequently, sanitation of the cavity under the X-ray guidance and fistulography with an assessment of the adequacy of drainage and exclusion of additional undrained jolts are peformed. In case of clinical manifestations of intoxication, local manifestations of phlegmon of the abdominal wall and retroperitoneal space, and infiltrative changes according to the results of ultrasound examination, CT scan of the abdominal cavity and retroperitoneal space is used to determine the location, prevalence of pyo-inflammatory changes and indications for open surgery [4, 15].

CONCLUSION

In the presence of trauma associated with a car accident and predictors of intra-abdominal damage, it is necessary to examine the abdominal wall in the area of seat belt hematomas (Seat Belt Sign) carefully. The diagnosis of post-traumatic inflammatory changes in the abdominal wall is based on clinical data, the results of ultrasound examination, computed tomography and laboratory diagnostic data with the exception of abnormal changes of abdominal organs.

REFERENCES

1. Girelli G., Di Natale R., Manocchi M.C., Lutman M. Seat belt syndrome. *Radiol Med*. 1993; 86(4): 444–452. PMID: 8248580.
2. Torba M., Hijazi S., Gjata A., et al. Seat belt syndrome, a new pattern of injury in developing countries. Case report and review of literature. *G Chir*. 2014; 35(7–8): 177–180. PMID: 25174292.
3. Masudi T., McMahon H.C., Scott J.L., Lockey A.S. Seat belt-related injuries: A surgical perspective. *J Emerg Trauma Shock*. 2017; 10(2): 70–73. PMID 28367011. DOI: 10.4103/0974-2700.201590.
4. Wagner A.C. Disruption of abdominal wall musculature: unusual feature of seat belt syndrome. *AJR Am J Roentgenol*. 1979; 133 (4): 753–754. PMID: 158297. DOI: 10.2214/ajr.133.4.753.
5. McCarthy M.C., Lemmon G.W. Traumatic lumbar hernia: a seat belt injury. *J Trauma*. 1996; 40(1): 121–122. PMID: 8576974.
6. Abbas A.K., Hefny A.F., Abu-Zidan F.M. Seatbelts and road traffic collision injuries. *World J Emerg Surg*. 2011; 6(1): 18. PMID 21619677. DOI: 10.1186/1749-7922-6-18.
7. Cuesta R.C., Casas I.M., Armenteros F.J., et al. Seat Belt Syndrome and the Submarine Effect: A Case Report. *Chirurgia (Bucur)*. 2017; 112(5): 624–626. PMID: 29088563. DOI: 10.21614/chirurgia.112.5.624.
8. Hefny A.F., Al-Ashaal Y.I., Bani-Hashem A.M., Abu-Zidan F.M. Seatbelt syndrome associated with an isolated rectal injury: case report. *World J Emerg Surg*. 2010; 5(1): 4. PMID: 20181086. DOI: 10.1186/1749-7922-5-4.
9. Velmahos G.C., Tatevossian R., Demetriades D. The “seat belt mark” sign: a call for increased vigilance among physicians treating victims of motor vehicle accidents. *Am Surg*. 1999; 65(2): 181–185. PMID: 9926756.
10. Santschi M., Echavé V., Laflamme S., et al. Seat-belt injuries in children involved in motor vehicle crashes. *Can J Surg*. 2005; 48(5): 373–376. PMID: 16248135.
11. Johnson M.C., Eastridge B.J. Redefining the abdominal seatbelt sign: Enhanced CT imaging metrics improve injury prediction. *Am J Surg*. 2017; 214(6): 1175–1179. PMID: 29029779. DOI: 10.1016/j.amjsurg.2017.08.041.

12. Thompson N.S., Date R., Charlwood A.P., et al. Seat-belt syndrome revisited. *Int J Clin Pract*. 2001; 55(8): 573–575. PMID: 11695084.
13. Hayes C.W., Conway W.F., Walsh J.W., et al. Seat belt injuries: Radiologic findings and clinical correlation. *Radiographics*. 1991; 11(1): 23–36. PMID: 1996397. DOI: 10.1148/radiographics.11.1.1996397.
14. Wotherspoon S., Chu K., Brown A.F. Abdominal injury and the seat-belt sign. *Emerg Med. (Fremantle)*. 2001; 13(1): 61–65. PMID: 11476415.
15. Slavin R.E., Borzotta A.P. The seromuscular tear and other intestinal lesions in the seatbelt syndrome: A clinical and pathologic study of 29 cases. *Am J Forensic Med Pathol*. 2002; 23(3): 214–222. PMID: 12198344. DOI: 10.1097/01.PAF.0000023001.32202.2D.

Received on 05.10.2018

Accepted on 18.12.2018